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(54) Method of Constructing Flat Building Block Modules from the Union of Two Frustums by Their Congruent Bases and Slot Connectors Complement for a Variety of Constructive or Amusing Applications

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METHOD OF CONSTRUCTING FLAT BUILDING BLOCK MODULES FROM THE UNION OF TWO FRUSTUMS BY THEIR CONGRUENT BASES AND SLOT CONNECTORS COMPLEMENT FOR A VARIETY OF CONSTRUCTIVE OR AMUSING APPLICATIONS

ABSTRACT

This invention broadly relates to modular building construction, and specifically to a method to make dihedrally connected building blocks and a built-in slot connector to erect or to make the structure of buildings, billboards, towers, roads, runways, dams, bridges, shore and offshore structures, furniture and their respective scale models for testing and design.

These scale model building block modules also can be profitable if used as teachers aids and toys.

SPECIFICATION

1. The general character of the class of article or the kind of process to which the invention relates.

OBJECTS OF THE INVENTION

It is a principal object of the present invention to unite the advantages of the bricks with those of the space structures" low cost production (extrusion, simple molding), low cost test scale modeling, high strength over weight ratio, maximum variety of polyhedral arrangement and low cost structural design and erection labor.

2. The nature in general terms of the articles or processes previously known or used which are intended to be improved or replaced by resort to the invention and of the difficulties and inconviences which they involve.

The construction of buildings by a plurality of similar simple polyhedral members, generally rectangular prisms, is a practice followed since ancient times for two main reasons. The obvious advantage is the low cost mass production of those members as is explained in Bardot's US Patent # 3,777,359, the less obvious advantage is the low cost construction of scale models for testing and design.
There are three main disadvantages of the simple brick:
They are too massive, too heavy.
They are assembled only into prismatic structures.
They are weakly connected.
Here-to-fore those disadvantages had been alleviated, generally, only demeaning the main advantages.
The solution of the massiveness problem by making holes in the members creates, once assembled, conduits which could be another advantage; however, those conduits are by means of simple molding not connected, they are parallel.

The second disadvantage have been partially overcome by making complex polyhedrons, see Hervath U S patent # 3,783,571. However, this second problem is not widely seen as such. Most designers are still exploring the mysteries of the cube structure; NASA space station structure, for example, having an expensive and very sophisticated system designed to be assembled into forty six different polyhedral arrangements, it's timidly cubical. The third problem, the weakness of the connection, perhaps the most elusive, had been attacked economically by perfecting a tongue and groove holding and locking systems, see Silvius' US Patent # 3,687,500, for a dihedral slot connection.
The building blocks of the art known as space structures are a different case. They are vertexially connected frames (see Pearce's U.S. patent 3,600,825). These structures dispel the three problems and the two main advantages entirely, generally adding problems of their own, such as low tolerance edge members' length.
Space structures may be visualized as a plurality of assembled polyhedral bricks from which everything has been removed except a small portion along the edges; those edge-members are connected at a vertexes or corners of the polyhedrons.
Space structures, generally, have two main component parts, a member and a connector. The member is an elongated prism or a tube whose cross section center is the edge of the polyhedrons and the connector is, usually ball shaped, at the vertex of the polyhedrons.
The space structure member, in principle, can be easily mass produced by extrusion or simple molding, the multiple connector in the other hand has elude heretofore inexpensive solutions. For this problem classical space structures, regardless of their high strength over weight ratio and the immense variety of shapes they can form, had been relegated in architecture usually to trusses or to secondary functions such as canopies. And in the construction toy industry, space structures had been shadowed by simple-face-connected-square-prismatic building blocks.
Another problem associated to the ingenious solutions invented since Bell's US patent 856,838 is the need of a highly specialized managerial workers, notably in McCormick's astonishing dihedral structures US Patent 4,686,800.

3. The Inventive idea which the new article or process embodies, and the way in which resort to it overcomes the difficulties and inconveniences of previous practices or proposals.

SUMMARY OF THE INVENTION
These and other objects are derived from a new method for creating modular building block units together with a new dihedral slot connector for erecting geometrical structures.
The designer engineer interested in geometrical structures will find more fruitful the study of a method applicable to any polyhedron than the individual description of a bunch of building blocks made with the said method.

The present invention method had evolved along two branches, pyramidal and conical. But, because cones are a class of pyramids to clarify and amplify the concept, the method will be resumed in a single description. The method consists in hypothetical steps as a guide for the design of modular building block units - modules, for short.

Solid Pyramidal Modules.
See Figures 1 to 6.
First, we choose a couple of concave face congruent polyhedrons, preferably space-fillers. We shall call them original polyhedrons. Second, by connecting any internal point and the vertexes, we divide the original polyhedrons into as many pyramids the polyhedrons have faces. We had created pyramids having a polygonal base, face of the original polyhedrons.
Third, we make frustums of the said pyramids - we remove the top parts of the pyramids in a plane between their base and the apex. Fourth, gluing the frustums by their congruent larger bases, we create a solid pyramidal module. The core of the new method is the creation of a building block by the bonding of two frustums by their congruent bases. Connecting the vertexes with the center of the volume, the original cube generates six pyramids of square base. The original tetrahedron generates four pyramids of triangular base. The original octahedron generates eight pyramids of triangular base. The original cub octahedron creates six square pyramids and eight triangular pyramids. The original tetragonal octahedron generates eight isosceles pyramids. The frustums of those pyramids are half of the solid pyramidal modules.
Therefore, solid pyramidal modules are frustums (of pyramids having the original polyhedron polygonal face for base and the original polyhedron center for apex) glued by their bases to others equal or different frustums with congruent bases.

Skeletal Pyramidal Modules.
A hole or holes through the module's bases made an access to the erected structure.
We shall call the solid modules from which a central portion has been removed, skeletal pyramidal modules, see Figure 10.

Distinctive Angle.
We shall call the angle (sum of two polyhedrons' dihedrals,) draw by a cross section perpendicular to the side of the modules, (see Figure 6 A2 B2 C2 D2 E2 for modules' cross sections) distinctive angle.

Solid Conical Modules.
The other preferred type of module to be made with the present invention method (see Figure 7 in the cube example) is constructed by two conical frustums glued by their bases. The conical frustums are frustums of cones having the original polyhedron centerpoint for apex and have a circle for base. These circles are inscribed, tangent kissing each side of the polygonal face of the original polyhedron and tangent also to neighbor circles.

It is imperative in this kind of module to mark them where the circle is touching the polygon side because these are the places where a module will be connected, according to the present method, to other modules (see Figure 6 A3 B3 C3 D3 E3 F3 for a top view of the conical module, and Figure 9 for a perspective view of an assembled polyhedron). In most conical modules we don't know, without marks, where the sides are. The conical module is limited by the fact that a circle can be inscribed in a limited number of polygons. However limited, conical modules may prove useful by its simpler design.

Skeletal Modules.
By means of a hole or holes through the bases or the extensive removal through the plane central portion, the designer may achieve lighter modules, skeletal modules of the two branches, pyramidal and conical, (see Figure 10) which allows for the separate construction of the module's sides by industrial processes other than molding, such as extrusion or metal sheet bending and for the making of holes through the sides to use a bolt like fastener to hold the modules to others of like shape.

Two Cross Sections
Solid and skeletal modules have, within the present method, two preferred embodiments represented by cross sections that we shall call "A" and "B" (see Figure 11). "A" is a truncation of the distinctive angle. The "B" cross section mainly apply to the conical modules. It is a semicircle or, in the skeletal configuration, could be a circle.
The conical modules are assembled according to the present method by means of a wrapping fastener, through holes in the member or magnetically.

Single Description
See Figures 19 and 20.

Cones have been studied and defined as pyramids with an infinite sided base, therefore both branches of the method can be reduced to one, and, because the core of the method, the union of the frustums by their congruent base, has not been previously explored, we think we have the right and duty to expose the following simpler and wider description of the method:
The union of two frustums by their congruent base.
The removal of a central portion through the plane section of the frustum.
The making of holes through the perimetrical side of the frustum.
The truncation of the perimetrical edge of the frustum.
The rounding of the perimetrical side of the frustum.
The magnetization of the frustum.
The magnetization of the module.

Built-in Dihedral Slot Connectors.
Until this point, the present invention modules have the need of a fastener, adhesive or magnetic, to be attached, connected, to be assembled, erected structurally. Now, see Figure 13, there is a fundamental leap that allows the

modules to connect on to another intersecting perpendicularly as does the type of connector developed first by Beck's US Patent 2,894,935.
The built-in dihedral slot connectors (slot connectors, for short) are not part of the method, but preferred embodiments to be built-in the modules created with the present invention method.

"A" & "B" Connectors.

The present invention slot connectors are of two types, one more suited for the "A" cross section (see Figure 16), we shall call it "A" connector, the other, which is round (see Figure 17), we shall call it "B" connector. The "A" connector improvement over previous slot-connectors designs (US Patents 3,177,611, 3,698,124, 3,940,100 etc.) consists mainly in augmenting the surface of contact between connectors, and with "B" connectors, the improvement comprise the easily radially deformable shape of the cylinder when pressed on a surface line parallel to its cross section center line. The present invention connectors are made preferably where the conical modules are marked or at the middle of the sides in the pyramidal modules. The "B" connector built at the marks of a conical skeletal "B" cross section module is a configuration easily adaptable to wide different processes such as inflatable toy modules and building construction iron modules.

4. A full description ar the best way of using or putting into operation the inventive ides. If there are drawings, the description should be preceded by a list of these drawings and should be related to them by the use of the numerals which appear upon them.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1 to 5 show the perspective views of three successive hypothetical stages, the extraction of pyramids from six polyhedrons, the making of frustums from the said pyramids and the creation of solid modules from the said frustums.
Figure 6 shows a chart of the tops views and common cross sections of the ten solid modules from FIGS> 1 to 5 and 7, both pyramidal and conical branches.
Figure 7 shows the perspective views of three successive steps, the extraction of cones from two cubes, the making of frustums from the said cones and the creation of solid modules from the said frustums.
Figure 8 shows a perspective view of the cub octahedron-octahedron structure made by a plurality of pyramidal solid modules directed to be jointed by their trapezoidal faces.
Figure 9 shows a perspective view of the cub octahedron-octahedron structure made by polarized conical solid modules directed to be jointed guided by their marks.
Figure 10 shows a perspective view of the making of skeletal modules pyramidal and conical.

Figure 11 shows two cross sections, "A" and "B", and a perspective view of four modules, one pyramidal and one conical with "A" cross section, and two conical, one solid and one skeletal with "B" cross section.
Figure 12 shows a top view of an "universal" conical, skeletal module.
Figure 13 shows a perspective view depicting five-type-modules slot connected to five-type modules.
Figure 14 shows a perspective view depicting two modules, one pyramidal with an "A" connector and one conical with a "B" connector.
Figure 15 shows a perspective view depicting prior art and present invention built-in slot connectors.
Figure 16 shows a perspective view depicting two "A" built-in slot connectors.
Figure 17 shows a perspective view depicting two "B" built-in slot connectors.
Figure 18 shows a perspective view depicting four frustums, two seven sided and two infinite sided and two modules made from the said frustums.
Figure 19 shows a perspective view depicting four truncated frustums, two modules made with the said frustums and three cross sections depicting the truncation.
Figure 20 shows a perspective view depicting four rounded frustums, two modules made with the said frustums; and three cross sections depicting the rounding.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention has two differentiable parts. One is a method to make building block modules (modules for short); the other is an apparatus, a built-in slot connector for the perpendicular connection of two flat members. Because the modules made with this method are flat members, both parts conveniently complement each other.

THE METHOD

To ease the reading we created a mnemonic chart. See Figure 21. The method may be described as along two branches, Pyramidal and Conical. Both branches comprise steps to create modular construction units which may be interconnected with others of like shape by means of a fastener, magnetically or connected by means of others modules of like shape to erect a hollow polyhedral structure after being provided by a built-in connector.
The method may also be described along one single line because cones are a class of pyramids. This freer description may help to produce modules that, when connected to others of like shape, create results beyond polyhedral structures.
We decide to expose the method in its two forms in the belief that a double description would clarify an elusive matter.

Pyramidal modules.

The preferred embodiment of the present invention will now be described in connection with Figures 1 to 5.

The first step is to choose a couple of polyhedrons (original polyhedrons). These may be two equal polyhedrons such as cubes 1, rhombic dodecahedrons 4 or tetragonal octahedrons 6; or they may be two different polyhedrons such as a regular tetrahedron 2 and a regular octahedron 3; or they may be two different polyhedrons, one with two different faces as a cuboctahedron 5 and a octahedron 3; or they may be a combination involving three or four different polyhedrons (four different polyhedrons is the limit for regular and semiregular space filling systems). In any case, we first choose two of them with congruent faces - common faces - such as the square FA1 of the cube 1 or the regular triangle FA2-3 in the tetrahedron 2 structure. In order to master the present invention method, we will begin by choosing polyhedrons that form the more simple structures, triangular and rectangular prisms. We may continue with regular space fillers, then semiregular space fillers, and finally get to the most irregular polyhedrons such as the wonderful Buckminster Fuller's "Quanta Modules". After choosing the original polyhedrons, we have to select a point inside them, not a point on the surface. If this point is at the center, equidistant to all faces, as in all our examples, the modules will be simpler; experimental or toy modules may require an eccentric point. The center point is usually found, in regular and semiregular polyhedrons, at the intersection of lines connecting the vertexes, connecting the centers of the faces, or connecting the vertexes with the centers of the faces.

The second step of the present new method involves the sectioning of the original polyhedrons 1, 2, 3, 4, 5 and 6 into pyramids PY1 PY2 PY3 PY4 PY5S PY5T PY6 defined by segments between the central points CP1 CP2 CP3 CP4 CP5 CP6 and their respective vertexes VE1 VE2 VE3 VE4 VE5 VE6.The step may also be expressed as the creation of pyramids PY1 PY2 PY3 PY4 PY5S PY5T PY6 having them the central points CP1 CP2 CP3 CP4 CP5 CP6 of the original polyhedrons 1 2 3 4 5 6 for apex and the original polyhedrons faces FA1 FA2-3 FA4 FA1-FA2-3 FA6 for base. From the From cube 1, the tetrahedron 2, the octahedron 3, the rhombic dodecahedron 4 and the tetragonal octahedron 6 is extracted one type of pyramid respectively, but from the cubactahedron 5 are extracted two types of pyramids, one square PY5S and one triangular PY5T. Three different pyramids from one polyhedron is the limit case for regular or semiregular space filler polyhedrons.

The third step is the making of frustums FR1 FR2 FR3 FR4 FR5S FR5T FR6 from the extracted pyramids PY1 PY2 PY3 PY4 PY5S PY5T PY6, this is accomplished by removing the top portion TP1 TP2 TP3 TP4 TP5S TP5T TP6 after a plane sectioning between the apex CP1 CP2 CP3 CP4 CP5 CP6 and the base FA1 FA2-3 FA4 FA1-FA2-3 FA6 of the said pyramids PY1 PY2 PY3 PY4 PY5S PY5T PY6. Because the thickness of the module is produced by this sectioning, the designer should consider it as a significant design variable. The

sectioning may be parallel to the base, as in our examples, creating regular trapezoidal perimetrical faces PF1 PF2 PF3 PF4 PF5S PF6.

The fourth step, the creation of the modules, is the heart of the method. Gluing one original polyhedron's frustum FR1 FR2 FR3 FR4 FR5S FR5T FR6 with any other original polyhedron's frustum FR1 FR2 FR3 FR4 FR!5S FR5T FR6 by their congruent base FA1 FA2-3 FA4 FA6 forms a third body; the modules M1 M2-3 M4 M5S M5T M6. As a result of the union of the frustums, the common base's polygon FA1 FA2-3 FA4 FA6 i(in all it's combinations) forms the perimetrical edges PE1 PE2-3 PE4 PE5S PE5T PE6. The cube 1 system's module M! is made by the union of two equal frustums FR1. The tetrahedron 2 octahedron 3 system's module M2-3 is made by the union of two different frustums FR2 FR3. The cuboctahedron 5 octahedron 3 system must have one square module M5S made from the union of two equal frustums FR5S and a triangular module M5T made from the union of two different frustums FR3 and FR5T. The rhombic dodecahedron 4 system's module M4 is made by the union of two equal frustums FR4. The tetragonal octahedron 6 module M6 is made by the union of two frustums FR6. An interesting column, the Buckminster Fuller's "Tetrahelix", is made with a module formed by two tetrahedrons frustums FR2. Summing up, original polyhedrons 1 2 3 4 5 6 are divided into pyramids PY1 PY2 PY3 PY4 PY5s PY5T PY6 from which are removed top portions TP1 TP2 TP3 TP4 TP5S TP5T TP6 forming the frustums FR1 FR2 FR3 FR4 FR5S FR5T FR6 that glued by their bases FA1 FA2-3 FA4 FA6 form the present invention examples of solid pyramidal modules M1 M2-3 M4 M5S M5T M6 with their distinctive and DA1 DA2-3 DA4 DA5S DA5T DA6 with their perimetrical faceted side PF1 PF2 PF3 PF4 PF5S PF5T PF6 and their perimetrical edges PE1 PE2-3 PE4 PE5S PE5T PE6.

The fifth step is described in connection with Figure 11, It consists of the truncation of the perimetrical polygonal edge 6 of the module 1 creating a perimetrical side 2 between the perimetrical faces 10, that is a wall (in a built structure) of a conduit along the edges of the polyhedron. We shall call this truncation "A" cross section; this truncation is useful also in molding and avoiding chipping. The following steps are described in connection with Figure 10.

The sixth step creates another conduit in the built structure, this time bigger and perpendicular to the face of the original polyhedron. It makes skeletal modules SM1 SM2-3 by the removal through the plane of the modules of a portion small 11 or large 1, but never reaching or modifying the perimetrical faces PF1 PF2 PF3 and their distinctive angle. This step is crucial; the designer creates with it conduits not only to get access into the structure but also as holder of tubes or spheres, as in Haug's US Patent 3,940,100.

The seventh step is the making of holes 8 through the perimetrical faceted side PF2 PF# of the module M2-3 for the use of a rivet or a bolt-nut 12 fastener to hold the module to others of like shape.

Conical modules

There is another type of modules made out with a similar method. They are modules made joining two conical frustums by their equal circular bases. They are, as the pyramidal modules, aimed to be assembled into hollow polyhedral structures.

The first step is to choose two polyhedrons. They may be equal or different, but they must pass three conditions: 1) their faces must be congruent, 2) have at least bilateral symmetry (this condition leaves out entire families of scalene tetrahedron spacefillers), and 3) a point on the face must be equidistant to the sides -a circle inscribed in them must touch each one of the sides (this condition leaves out, for example, elongated rectangles and truncated triangles). We may choose any of the polyhedrons of Figures 1 to 5, but for the present new method example we'll refer to cubes, as shown in Figure 7.

The second step is to choose a volume point or the central volume point CP1 in each of the polyhedrons 1.

The third step is to inscribe a circle 3 on the faces FA1. The circle 3 must be tangent to the sides 5 of the faces FA1 and tangent to their neighbor circles 3 in a point usually, but not necessarily, at the middle of sides 5.
The tetragonal octahedron circle, for example, is inscribed in a isosceles triangle and touches two sides and two neighbor circles off the side respective centers.

The fourth step involves the construction of cones 6 equal to those defined by the said volume central points CP1 and their respective inscribed circles 3. The cones may be regular, with their apex CP1 in a line perpendicular to the center of the base, or irregular, such as the cone of the tetragonal octahedron.

The fifth step is to make frustums 7 from the said cones by removing the top portions 8 after sectioning the said cones 6 through a plane 13 that goes between the base 9 and the apex CP1. The preceding steps guide the construction of a couple of base congruent frustum of cones extracted from two face congruent polyhedrons.

The sixth step indicates the creation of modules 10 by gluing the said frustums 7 from one original polyhedron 1 with the said frustums 7 from the other original polyhedron 1 by their larger congruent bases 9.

The seventh step is to make marks 12 to indicate where the circles were tangent 11 to the edges 5 of the original polyhedrons 1 to show the place where a module must be attached to others of like shape to be erected.
The next two steps, eight and ninth, are described in relation with Figure 11, they are to truncate the perimetrical edge 6, to remove the tip of the distinctive angle 7, and to make a single perimetrical side 2 between the perimetrical sides 10, useful in molding and to avoid chipping.

The last steps are described in relation with Figure 10.

The tenth step is to remove through the module's plane a central portion, either small 13 or large 3, but never reaching or modifying the perimetrical sides 14. As a result of this step, we obtain skeletal modules.

The eleventh step is to make holes 8 through the perimetrical sides 14 where indicated by the marks of step number seven to attach the modules by means of a fastener, according to the present invention. There is a further simplifying preferred embodiment of the present new method for conical modules; it will be described in relation to Figure 11.

The twelfth step consists in the rounding of the perimetrical edge 7, represented in a module's cross section as a semicircle 8 tangent to the perimetrical faces 10; this is the "B" cross section. This step together with the tenth makes a module from an inexpensive ring 4; a fact that may take today's sophisticated space frame technology to market areas untaught before.

The module 1 top view depicted in Figure 12, holed between angles of thirty degree 2, twenty five degree 3 and thirty five degree 4 disposed in ninety degree specular arrangement may be assembled, according to the invention, into five space filling structure by means of a wire fastener and maybe used in concrete reinforcing, not only as the ultimate reinforced of the concrete, but also as scaffolding and holder of the forms.

The modules are a somewhat flat rigid elements; their embodiments are determined by two type of sections: those of the plane and those of the thickness or cross section.

The plane sections of a module results in polygons; the middle plane section is the face of the original polyhedron.

The cross section (perpendicular to the sides towards the center) has an angle that is the same of two original polyhedron bisected dihedrals.

As a guide for the drafting of modules the designer of advanced modules may create, for the manufacturer of modules, a chart of top views (face sections) and cross sections of the modules such as the one depicted in Figure 6, which shows the six modules from Figure 1 to 5 top views A1 A2 B1 B3 C1 C3 D1 D3 E1 E3 F1 F3 (they represent both faces of the modules, therefore not hidden lines are shown) and cross sections A2 B2 C3 D2 E2 (each one represents all the polygons sides, with the exception, in these examples, of the tetragonal octahedron 6 where two cross sections A2 E2 represent three sides 7g 7g 5g.

The cross sections are the same for both pyramidal and conical modules; they have two acute angles 5c 6c 7c 9c 9c each one half the size of the original polyhedron's dihedral(s), and the sum of those angles form distinctive angles, in the sense that you can differentiate two pyramidal square or triangular modules by these angles.

Each top view shows two polygonal perimeters, one external (face of the original polyhedrons) 5a 5d 61 6d 71 7d 8a 8d 9a 9d 10a 10d and one internal (which is not critical) 5a1 5d1 6a1 6d1 7a1 7d1 8a1 8d1 9a1 9d1 10a1 10d1. Both perimeters have the same number of sides and the same angles between sides.

The sides and angles of the conical module top views are hypothetical and represented by a broken line 5ah 6ah 7ah 7a1h 8ah 9ah 9a1h 10ah 10a1h. At some convenient point on the lines from the tangential points 5f 6f 7f 8f 9f 10f to the plane center 5e 6e 7e 8e 9e 10e, a mark or hole 11 11a 11b 11c 11d 11e shall be done to indicate where to attach one module to another according to the present invention method.
The following list shows approximate proportional lengths and angles from Figure 6. Angles are mandatory but some lengths are given to conform with volume standards given by Peter Pearce's "Structure in nature is a strategy for design."

5g = the unity (u)
6g = time square root of 2
7g = (u) times square root of 3 divided by 2
5b = 90 degree angle
6b = 60 degree angle
7b = 70 degree angle
8b = 110 degree angle
5c = 45 degree angle
6c = 35 degree angle
9b = 35 degree angle
7c = 62.5 degree angle

MODULES SINGLE DESCRIPTION

The present invention method will not be described to give more freedom to the designer referring to frustums of unspecified amount of sides and dihedral angles - unspecified in the same sense we may call unspecified the amount of spokes a wheel could have from the hub to the rim and in the mathematical sense being the infinite sided polyhedron a circle - to frustums not necessarily related to predetermined polyhedrons; the present invention method works with any frustum, with any pair of frustums of congruent base. Removals, holes, truncations and rounding will be done in the frustum instead of being performed in the constructed module. This wider method may be to create some chaos but also unexpected wonder and beauty.
Although frustums always have one base larger than the other, we will name them for further clarity.
This description will be done in connection to Figure 18 as follows: A method to produce a relatively flat module from two frustums 1 and 1.1 having each frustum two opposite bases 2, 3, 2.1 and 3.1, one larger 3, and 3.1 than the other 2 and 2.1 (each base may have from three to an infinite number of edges), one perimetrical faceted side 4 (with as many facets as the bases 2, 3, 2.1, and 3.1 have edges) between the bases, and one critical perimetrical edge 5 between the larger base 3 and the perimetrical side 4; being one frustum's larger base 3 congruent to the other frustum's larger base 3.1.

The method comprises the following steps:

a) The making of holes 7 through the said frustum's bases 2, 2.1, and 3 3.1 in order to allow access to the structure, connect one module to another and eventually connect one frustum to another making skeletal frustums.
b) The making of holes 8 through the said frustum's perimetrical sides 4 in order to connect one module to another.
c) The congruent union of the said 1 and 1.1 frustums' bases by their said larger congruent bases 3 3.1 forming a module 6. The method further comprises two additional steps described in connection to Figures 19 and 20 respectively.
d) The truncation of the said frustums 1 critical perimetrical edge through planes perpendicular 6 to the larger base 3, creating a new faceted side 2 between the perimetrical side 4 and the larger base 3.
e) The convex circular rounding of the said frustums' perimetrical side 9 in such a manner that part of the cross section of the frustum shows a quarter of a circle defining the rounding. The center 11 of that hypothetical circle is on the large base 10, and the length of its radios 12 is equal to the distance between the frustum's bases 13 and 10.

ASSEMBLING OF MODULES

The assembling or erecting of the modules will be described now in connection to Figures 8 and 9. To erect the modules into a building structure is to reverse the process of its construction, a process in which the volume looses an interior portion and it is divided into as many units, pyramids, as faces has the polyhedron. The pyramidal module has two perimetrical sides 3 divided into as many trapezoids 5 as the plane section of the module has sides. For the modules to be assembled, erected into polyhedral structures, its trapezoids 5 must be congruent bonded - attached to other module trapezoids.
The conical module has two perimetrical sides 6 divided by a perimetrical edge 7, the module is marked 8 radially or/and holed 9 to show the lines 10 on the perimetrical edge that must be shared by the modules to be assembled, erected, into polyhedral structures. The conical modules may be held together by means of a wire-like fastener 11 or may held magnetically 13. These magnetic ring modules may be provided by one or more insulators 12. Figure 9 shows a type of structure, a cuboctahedron-octahedron system that may be assembled with polarized 13 modules without insulators 12, the modules must be circularly magnetized 13 (perpendicular to the bases 14.)

BUILT-IN DIHEDRAL SLOT CONNECTORS

Until this point, the present invention module sides are connected parallel to each other by means of a fastener intersecting them at ninety degree. Now, a new type of module, with a built-in connector, will substitute the fastener. This new module will intersect others at ninety degree, as depicted in the schematic perspective view of Figure 13. Another reason why we've selected the five structural systems depicted in Figures 1 to 5 will become apparent. The five

systems interact making what we may call three super-systems. In reference to Figure 13, the cube-system 2 intersecting connector 1 is a smaller cube module. The rhombic dodecahedron system 4 intersecting connector is a smaller regular tetrahedron module 3. The cuboctahedron - octahedron system 6 intersecting connector is a smaller tetragonal octahedron module 5. And the tetragonal octahedron system 9 intersecting connectors are of two kind: the cuboctahedron-octahedron-square module 7 and the cuboctahedron-octahedron-triangle module 8. For the purpose of a ninety degree intersecting connection, the present invention has two preferred embodiments, they are depicted in a perspective view in Figure 14. One more suited for the pyramidal module with "A" cross section 1, we'll call it "A" connector 2. The other, of a round configuration, more apt for the conical module 4 (here, in a simplified cross section) we'll call it "B" connector 3. They are depicted in comparison with prior art in Figure 15. It may be said that prior art slot connectors are a built-in connector for perpendicularly connecting two relatively flat members 2 of equal thickness, essentially by making an opening 1 slightly larger that the width of the member if the member is undeformable rigid. The opening 1 should be slightly smaller if the material is somewhat deformable and we want a grip or locking between the parts. The present invention connectors are also built-in connectors 3 for perpendicular connecting two relatively flat members 4 of equal thickness; also the rules for the openings size apply.

The "A" type will be described in relation to Figure 16. It is a built-in connector for connecting two underformable rigid flat members 5. The connector comprises a shape slightly smaller 1 than two triangular prisms 2 specularly ubicated sharing their longitudinal right angle edges 3 (ultimately, because the prisms are smaller than the described prisms, there is a gap between prisms 2 instead of touching).

The prisms have their larger faces 4 mutually parallel, the member 5 attached to the said larger faces 4 and to two coplanar prisms' triangular faces 6; the said prisms' common edge 3 is a line in the middle plane 7 section of the member 5. To accomplish a smoother connection and avoid chopping, the front end faces' 8 shorter edges 9 and the right angle edge 3 should be obviously rounded or truncated.

The "A" connector novelty over prior art is minimizing the weakening of the member and enlarging the surface of contact. Because the right angle edge 3 results in the "B" connector when rounded up to semicircle, the following description in reference to FIG 17 is intended as further clarification. The "B" connector is a built-in connector for connecting two deformable right flat members 5. It comprises a shape slightly larger 1 than two semicircular prisms 2 specularly ubicated facing their curved faces 3 having their flat rectangular faces 4 mutually parallel at a distance equal to the diameter of the prisms' semicircle multiplied by the square root of two (because ultimately the prisms are larger than described here, the distance between rectangular faces is smaller). The member 5 is attached to the said prisms' rectangular faces 4 and to two coplanar semicircular faces 6. For the purpose of a smoother connection, the semicircular front end faces' 7 curved edges 1 should be rounded or truncated.

In building block scale modeling, the problem of inexpensive locking, gripping or snap action is very important. The present invention "B" connector solution gives a large margin of manufacture tolerance. The contact lines 8 between connectors are radius of a semicylinder. Cylinders, when pushed in a surface line parallel to its cross section center, deform easily, which is what the designer looks for in a slow-wear holding system.
The "B" connector is now ready to interconnect with the "A" connector; if it is to in our interest to unite the systems, the "B" connector will provide in strength by means of a bridge 9 between the closer points of the prism' curved faces 3 from the longitudinal middle 10 toward the member, being he bridge never thicker than the gap between prisms. The "B" connector is presented in its critical part and without scale considerations, mainly but not limited to be used with the present invention modules. It is in the hands of the designers to complete them with proprietary specification in a variety of markets.
We hope our method to serve (together!) with new specific inventions in a wide range of industries and markets. The present invention encourage the construction of hollow modules, such as inflated units made out of two equal flexible sheets welded in such perimeters that, when inflated, resemble conical cross section "B" skeletal with "B" connectors modules. For advance constructive applications, the designer may look for known data published in Coxeter's "Regular Polytopes", Buckminster Fuller's "Synergetics", Arthur Loeb's "Space Structures" and the above mentioned Pearce's book. In a less advanced stage, the designer may use school texts or our basic examples. For amusing (puzzle) applications, the designer may create proprietary data or a system for creating such a data.

What we claim is:

1. A method of producing a flat building block module from two frustums, comprising each frustum; A0 two opposite polygonal bases, one larger than the other; B0 one perimetrical faceted side between the bases; C) one critical perimetrical edge, between the larger base on the perimetrical side; D) a common, larger base congruent with the other frustum's large base, comprising the method the following steps; a) the congruent union of the said two frustrums by their congruent large base, creating a building block module; b) the removal of a central portion through the said frustum's bases without affecting the said frustum's perimetrical side, creating a skeletal frustum; c) the making of holes through the said frustrum's perimetrical side.

2. The frustrum's perimetrical edge of claim 1 further co prisming its truncation through planes perpendicular to the large base, creating a new perimetrical side between the frustum's perimetrical side and the larger base.

3. The frustum's perimetrical side of claim 1 further comprising such a convex rounding that part of the cross section of the frustum shows a quarter of a circle defining the said rounding. The hypothetical circle to which the said quarter belongs has its center on the large base and its radius is equal to the distance between the frustum's bases.

4. The frustum of claim 2 further comprising marks and holes radially disposed from the center of the small bases to the perimetrical edge at 30, 25, 35, 35, 25, 30, 30, 25, 35, 35, 25, 30 degrees.
5. The frustums of claim 3 further comprising marks the holes radially disposed from the center of the small bases to the perimetrical edge at 30, 25, 35, 35, 25, 30, 30, 25, 35, 35, 25, 30 degrees.
6. The building block module of claim 2 further comprising the circular magnetization perpendicular to its bases and the provision of one or more insulators to interrupt the flow.
7. A built-in slot connector for perpendicularly connecting two flat member, comprising the connector a shape slightly smaller than two right angle prisms specularly ubicated sharing the longitudinal right angle edge and having their larger faces mutually parallel, being the member attached to the said larger faces and to two coplanar prism's triangular faces, the said prisms' longitudinal right angle edge is a line of the middle plane section of the member.
8. A built-in connector for connecting perpendicularly two flat members comprising the connector a shape slightly larger than two semicircular prisms ubicated specularly facing its curved sides and having its flat rectangular faces mutually parallel at the distance equal to the diameter of the semicircle multiplied by the square root of two, being the member attached to the aid rectangular faces and to one pair of coplanar prisms' semicircles.
9. The prisms of claim 8 further comprising a bridge between the closer points of the said prisms' covered faced from the prisms' longitudinal middle towards the member body, being the said bridge never thicker than the gap between the prisms' curved faces.
10. The prism's right angles of claim 7 further comprising a bridge between the closer points of the said right angles from the prisms' longitudinal middle toward the member body, being the bridge never thicker than the gap between prisms.

5. If desired, other ways in which the inventive idea may be used or put into operation.

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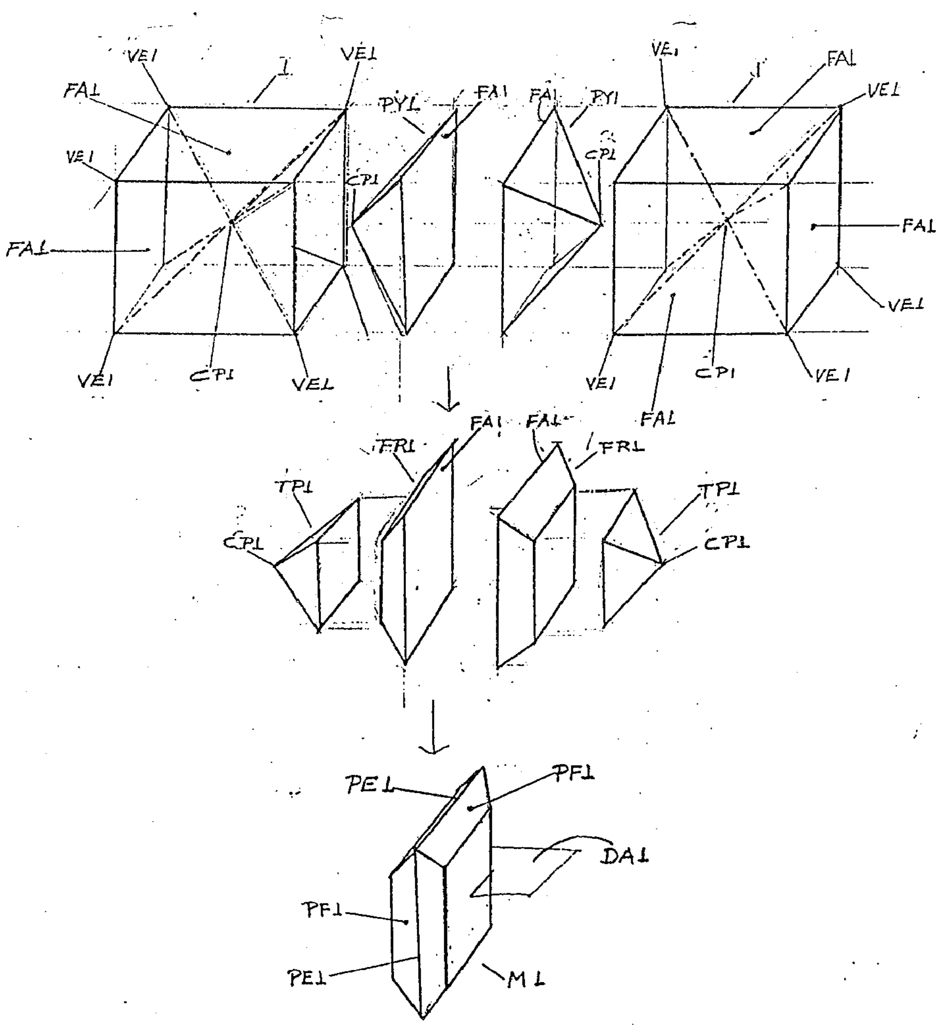

FIG. 1

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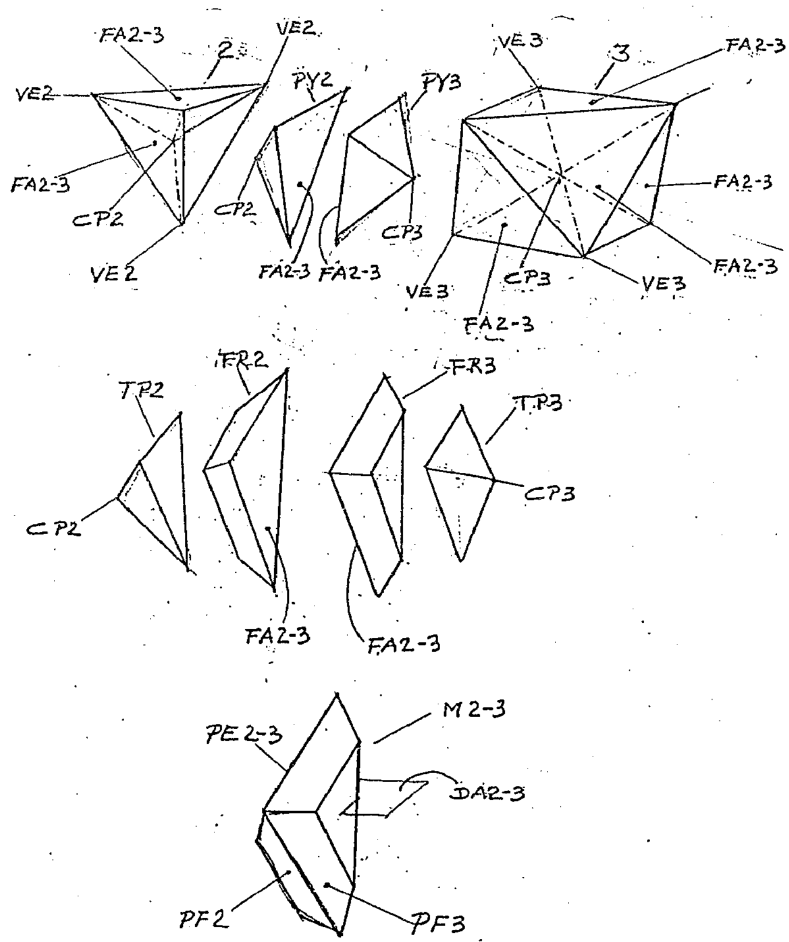

FIG. 2

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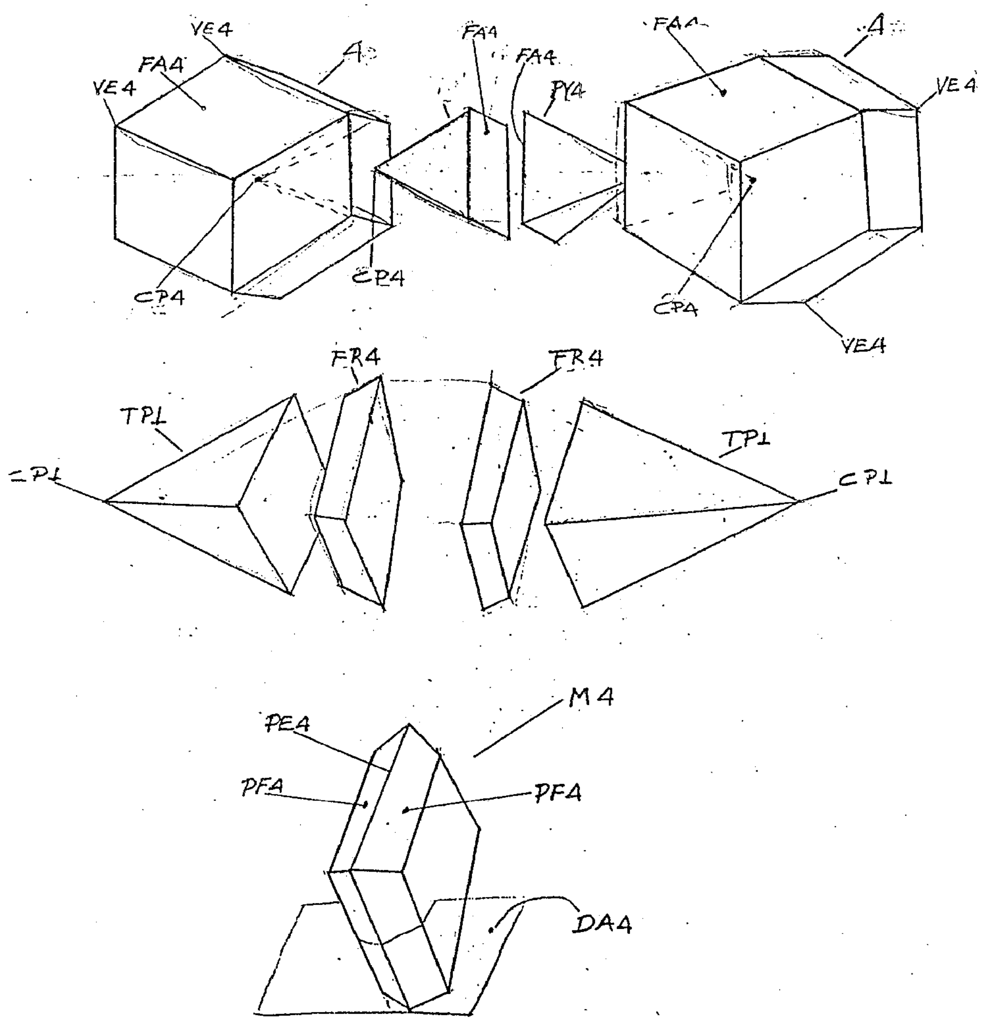

FIG. 3

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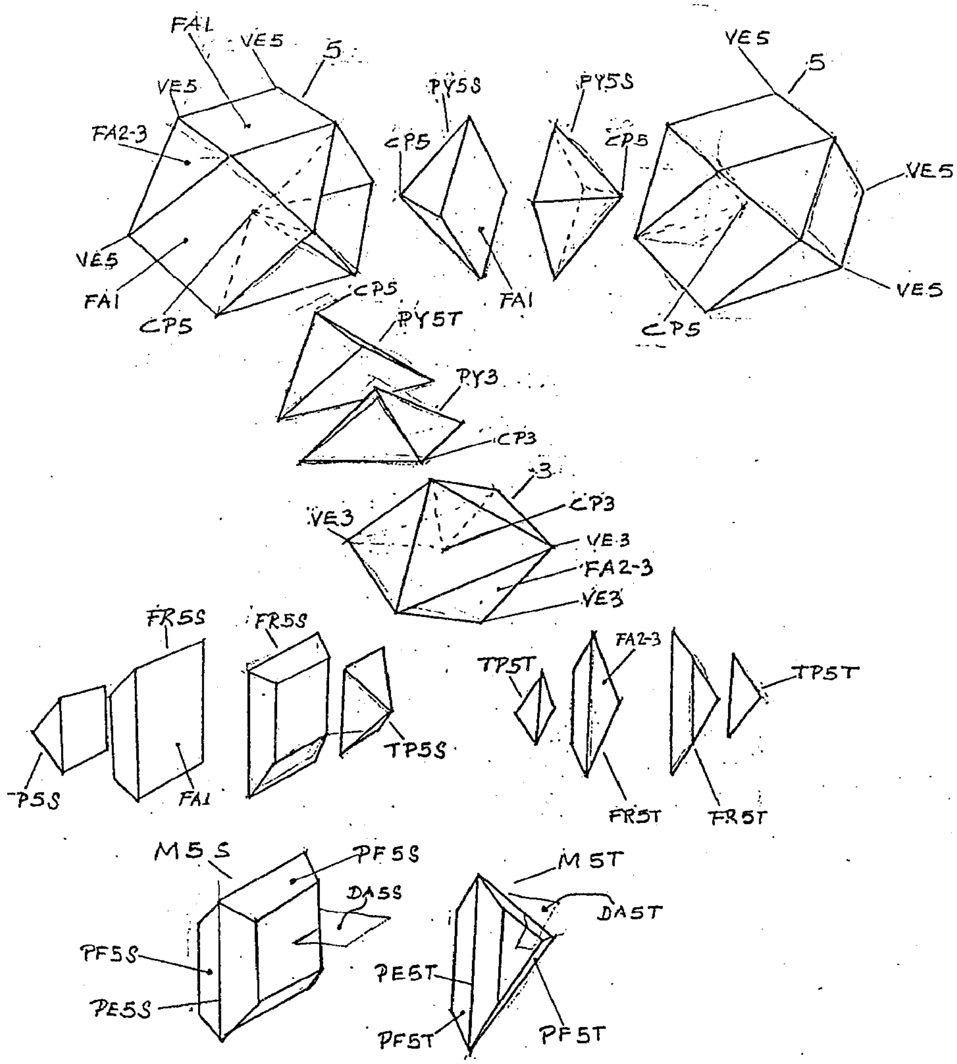

FIG. 4

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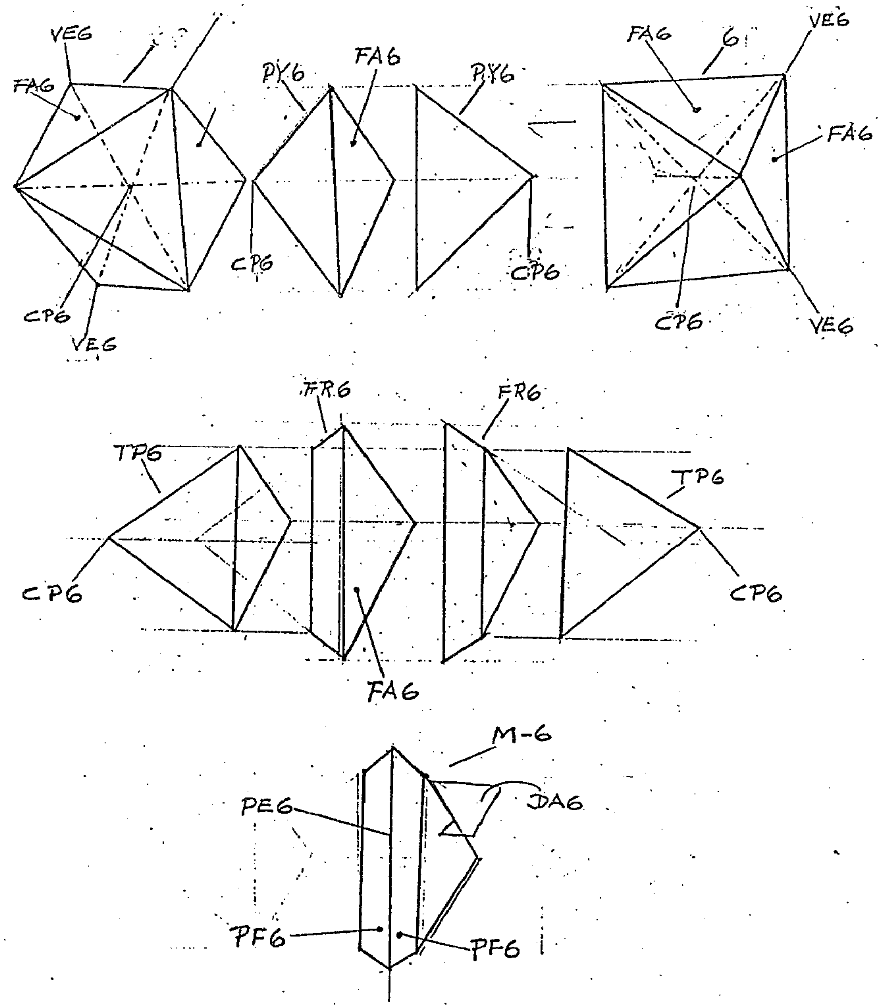

FIG.5

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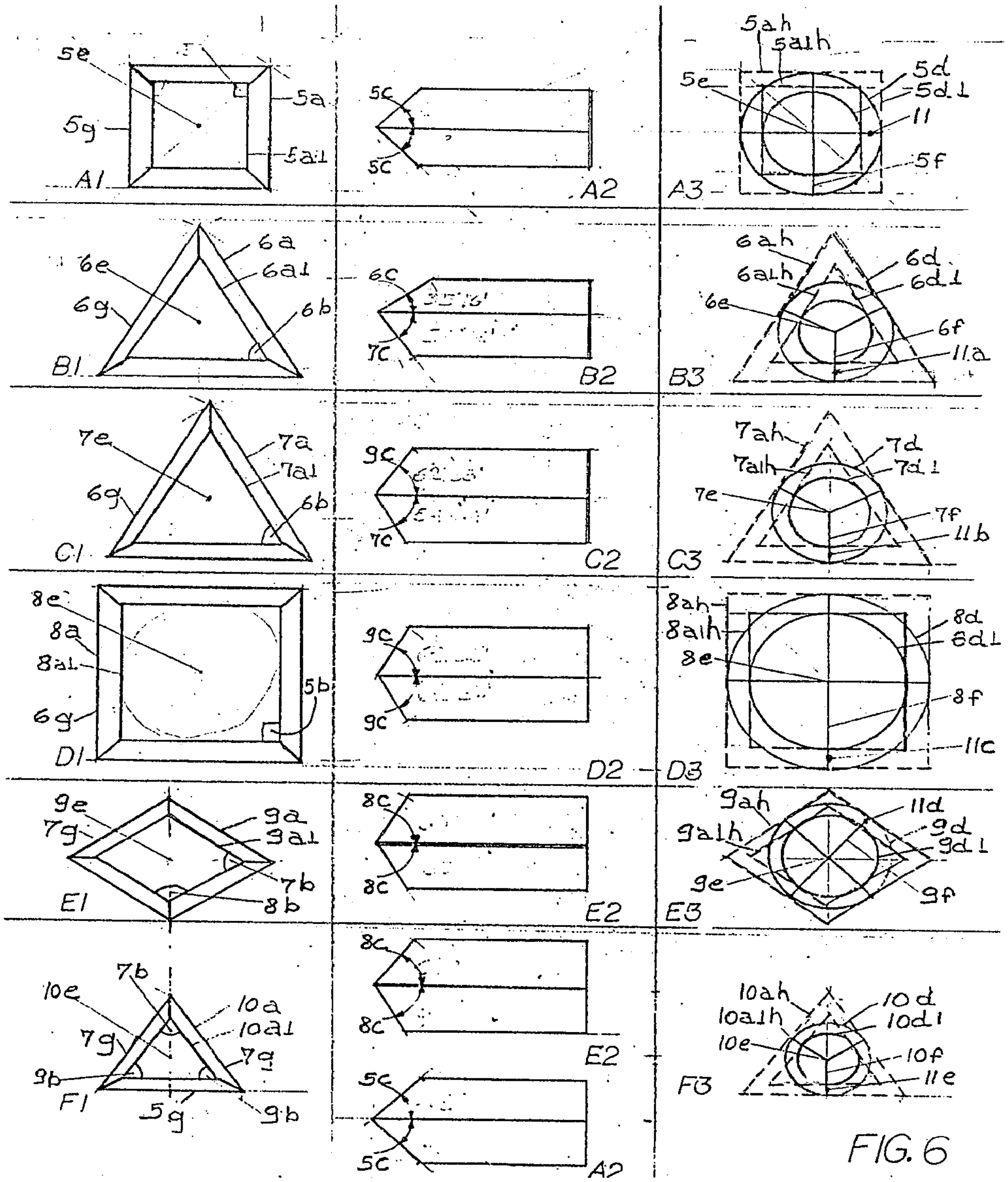
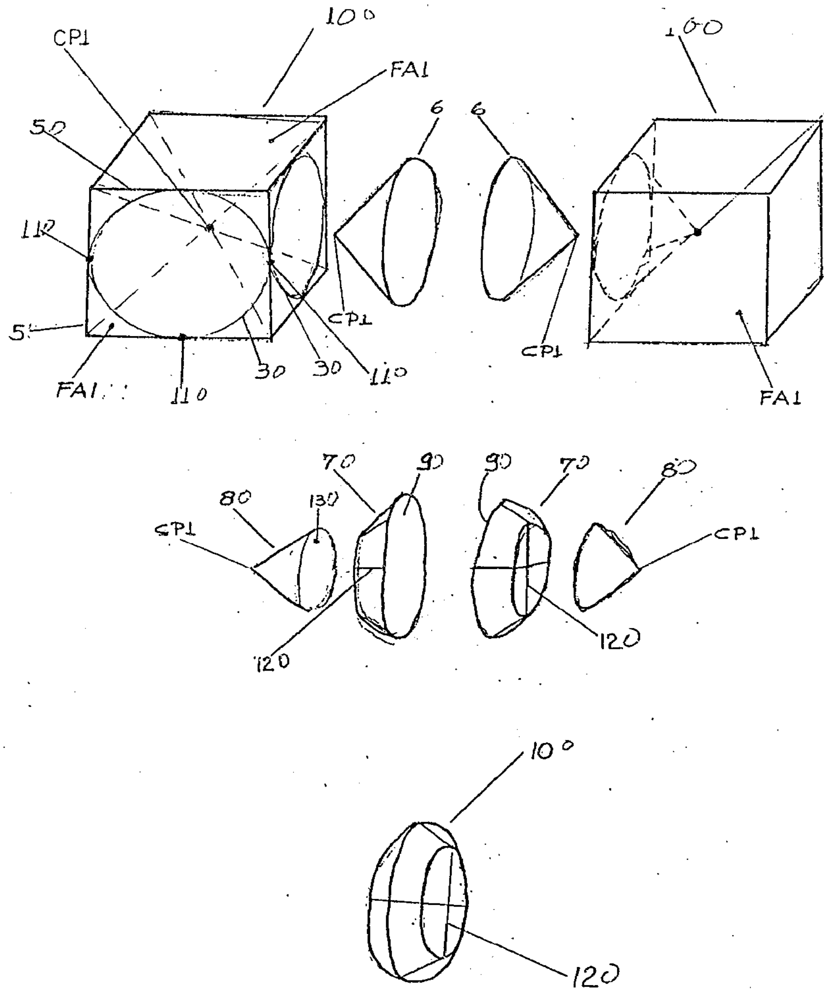


FIG. 6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120

FIG. 7

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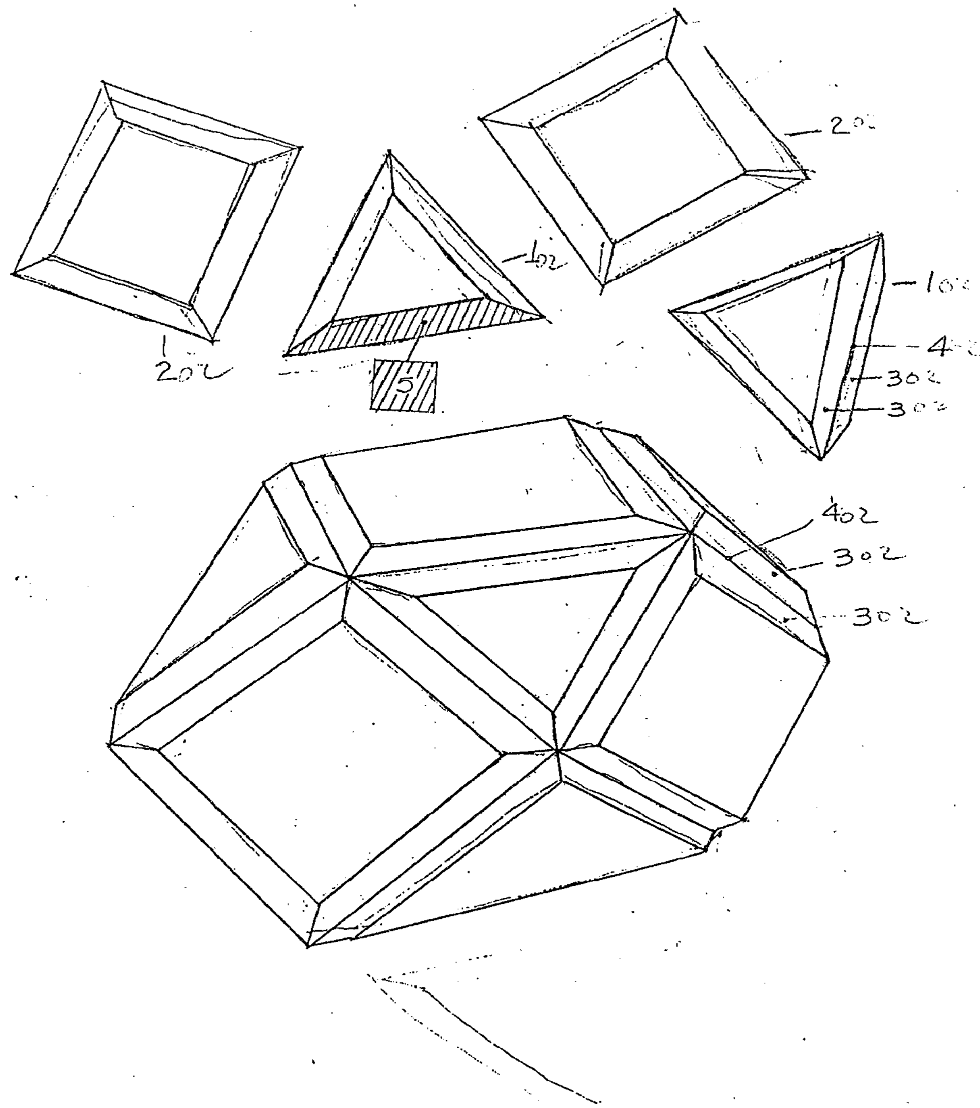

FIG. 8

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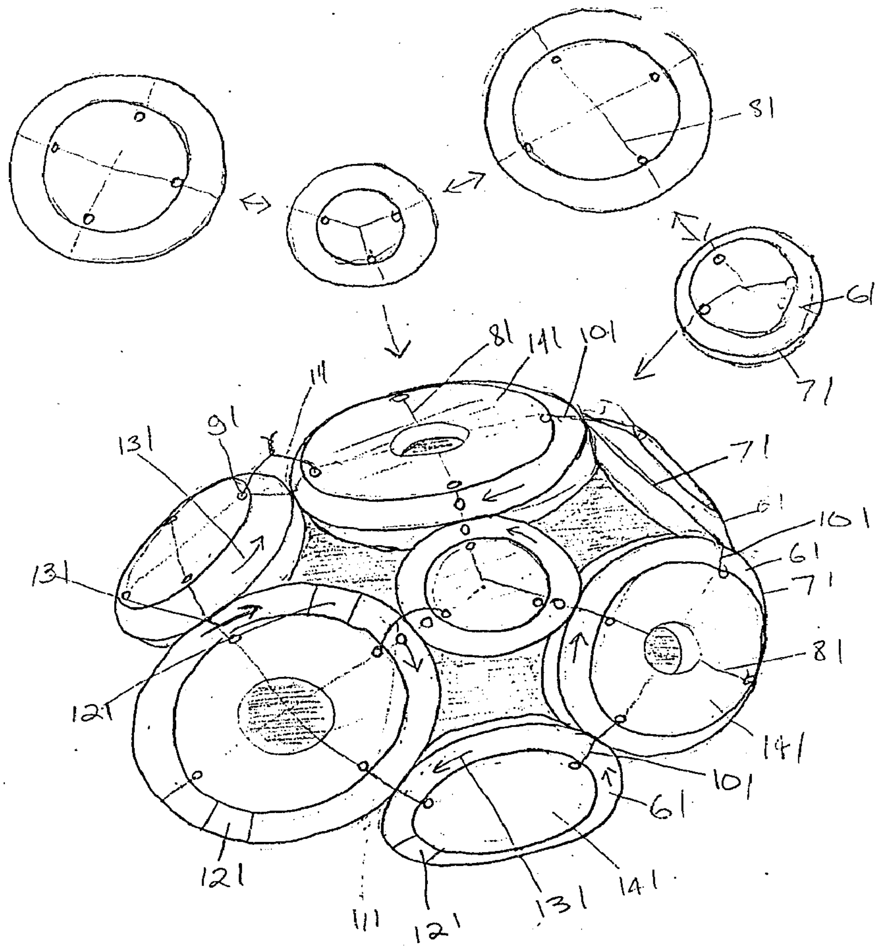

FIG. 9

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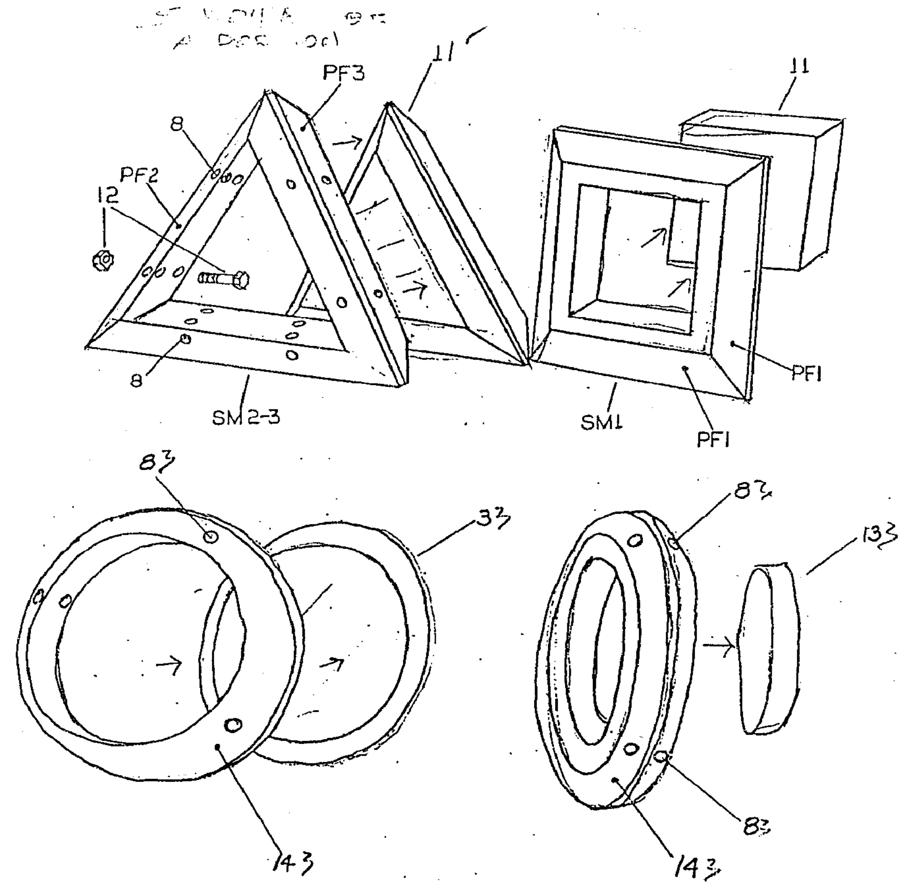

FIG. 10

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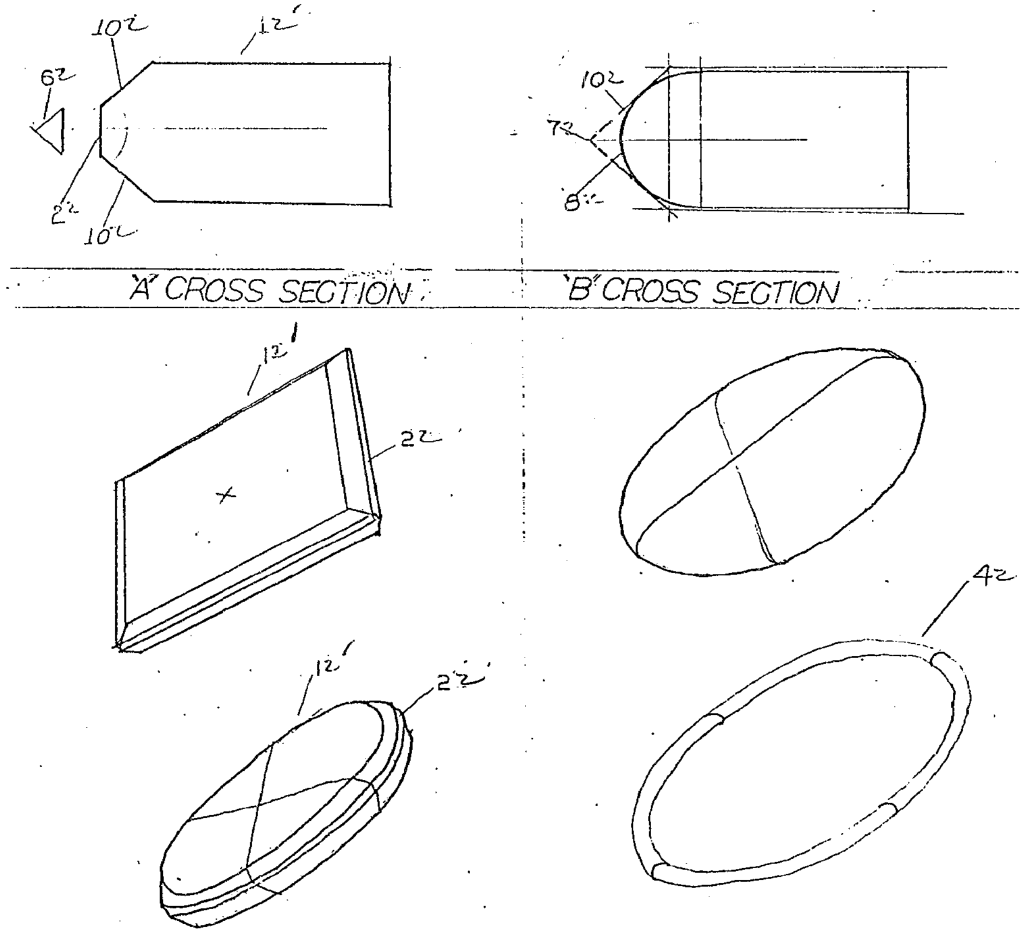

FIG. 11

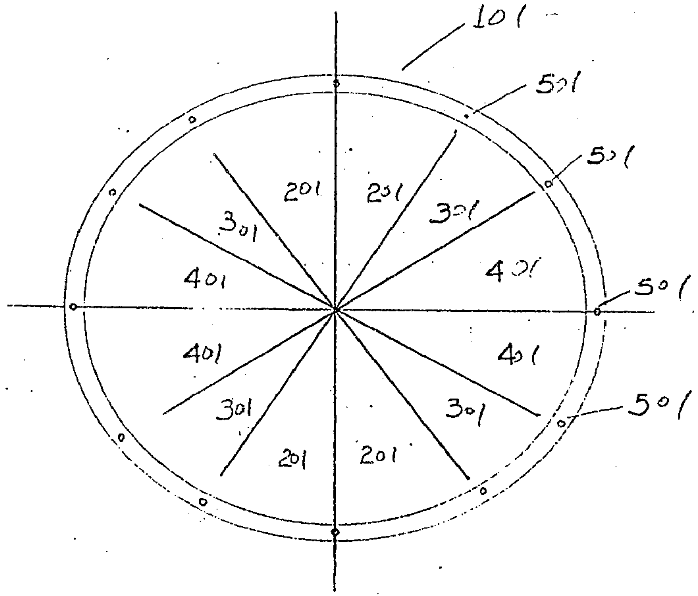
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FIG. 12

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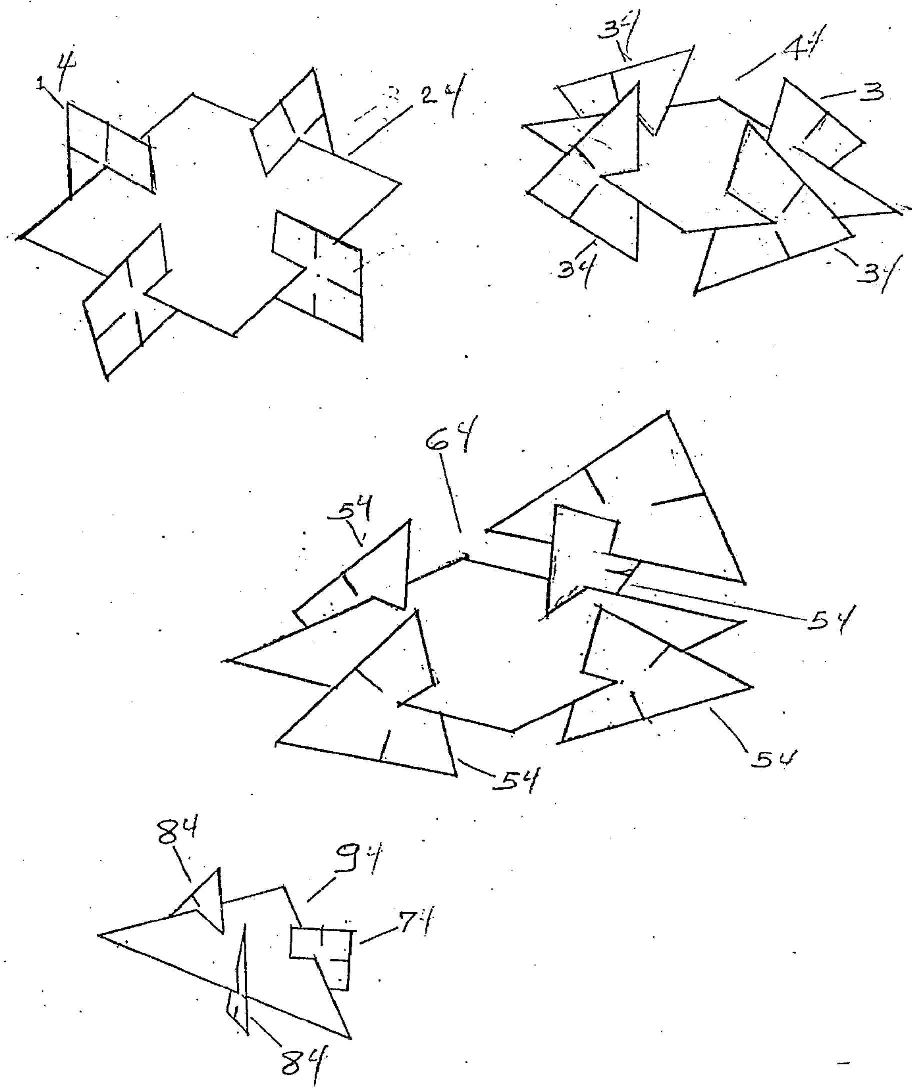

FIG. 13

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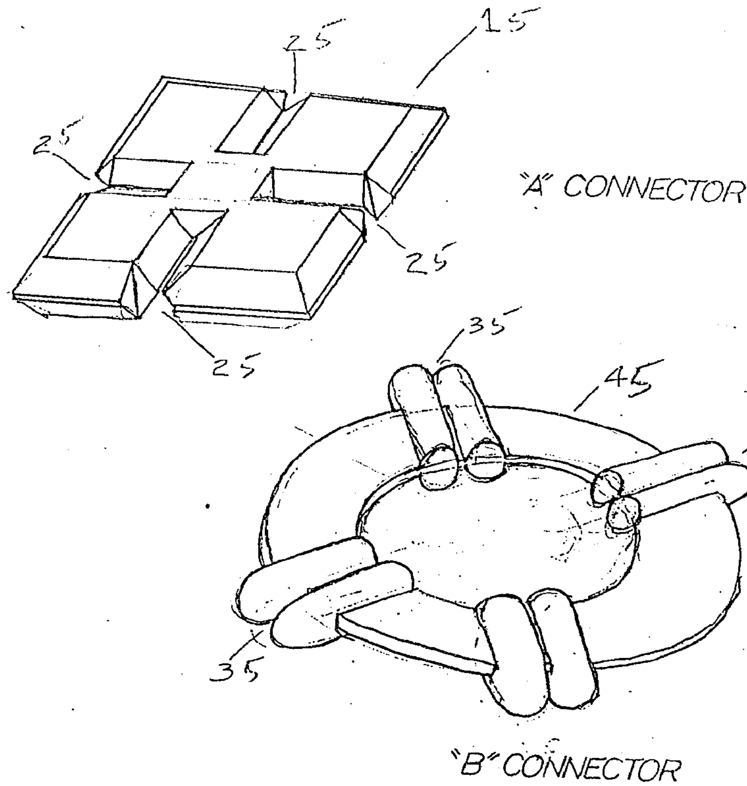

FIG. 14

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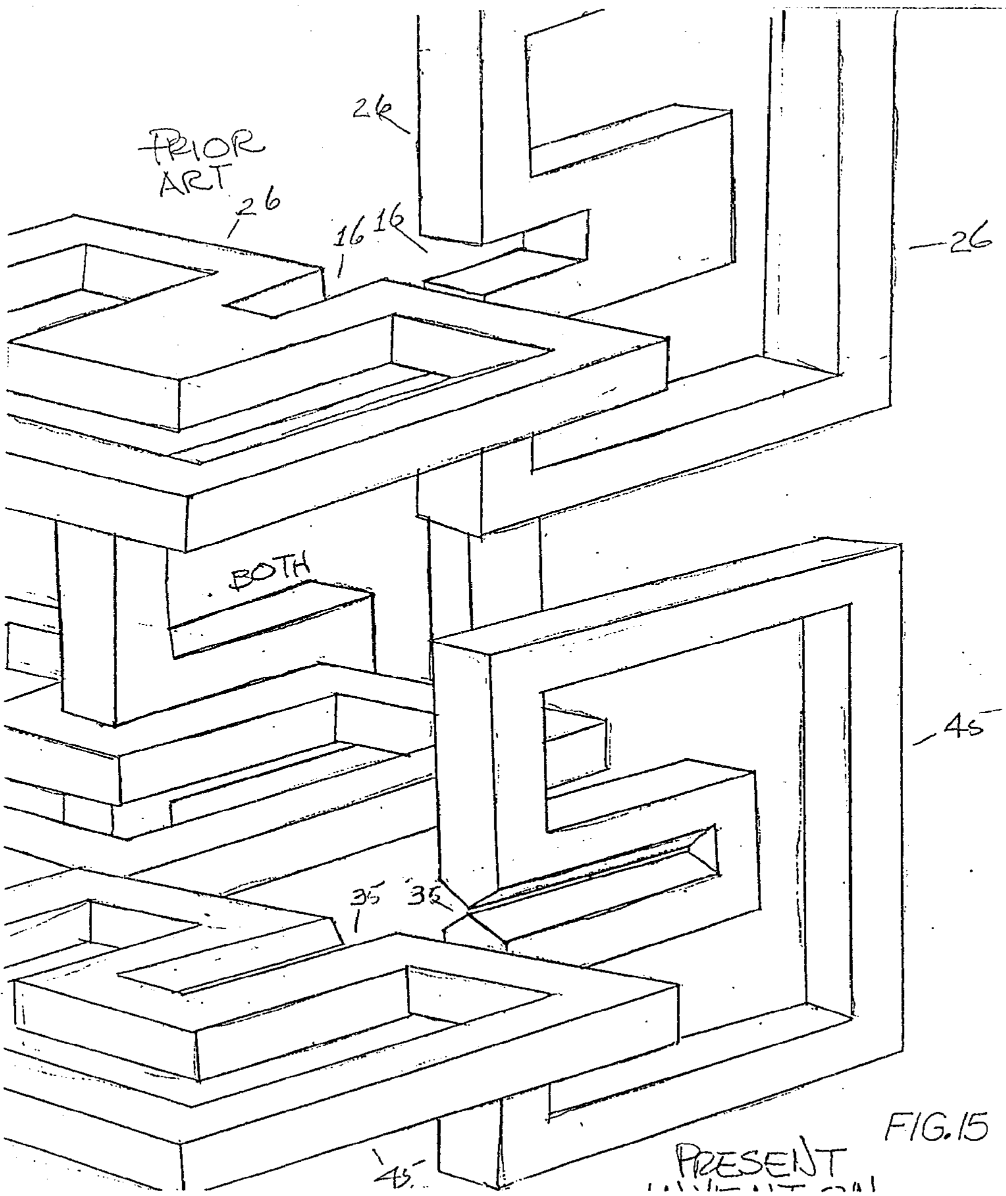

FIG.15

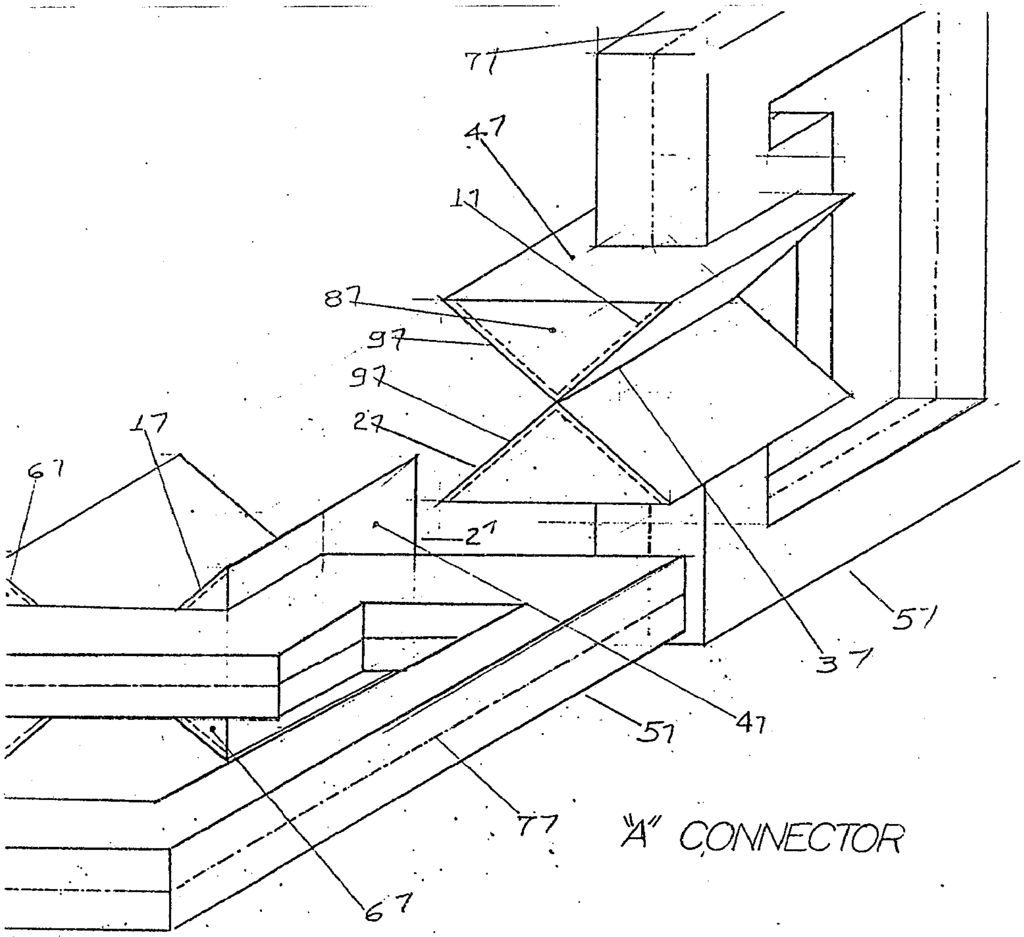

FIG. 16

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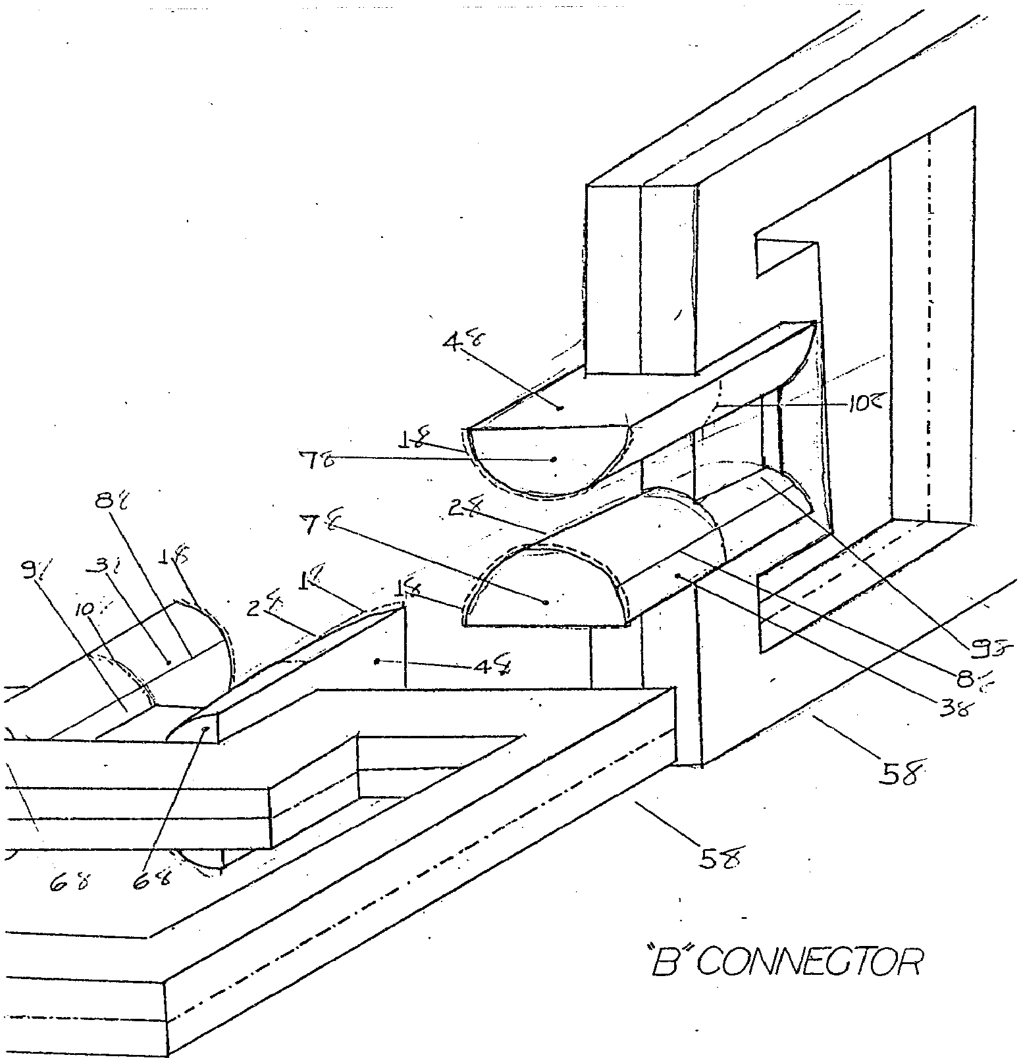

FIG. 17

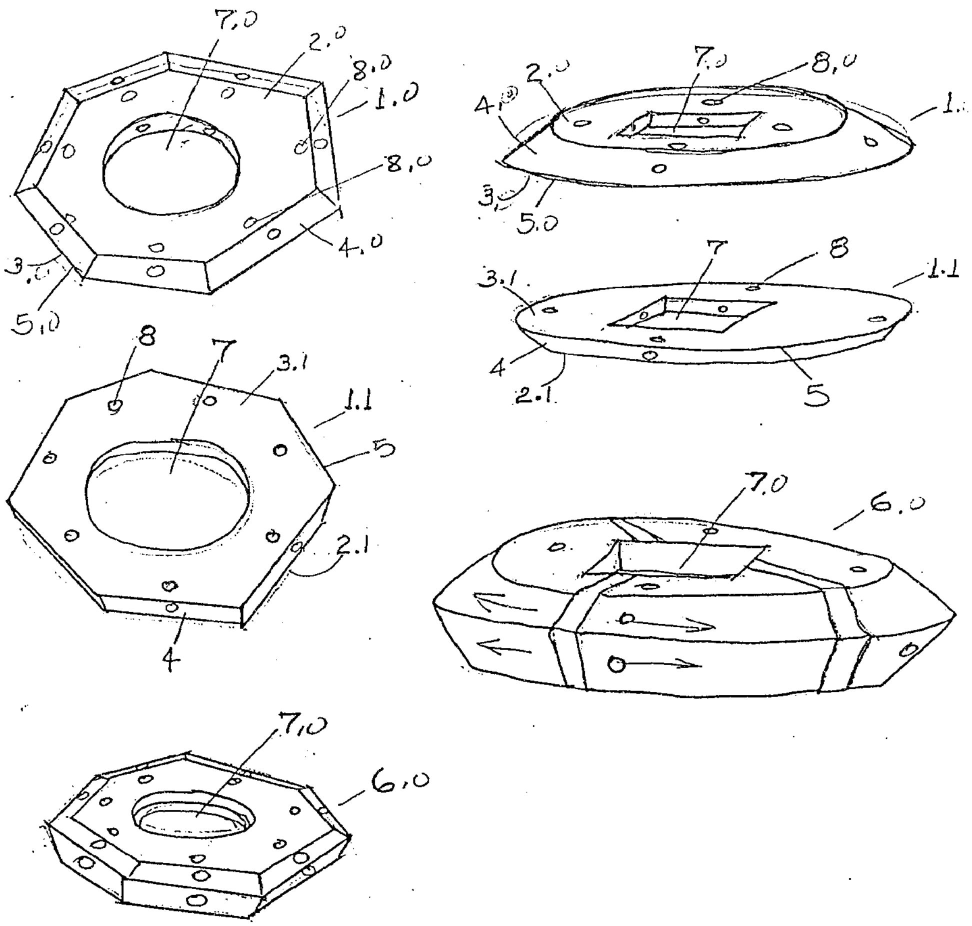
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FIG. 18

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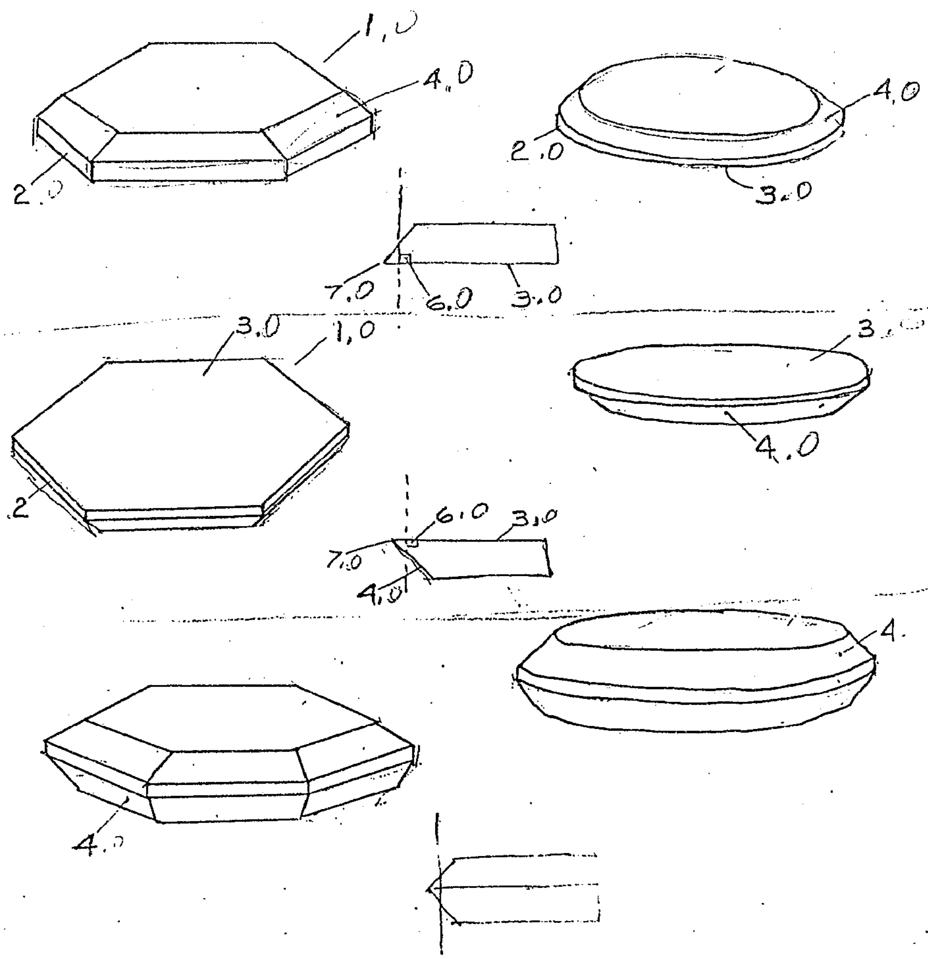

FIG. 19

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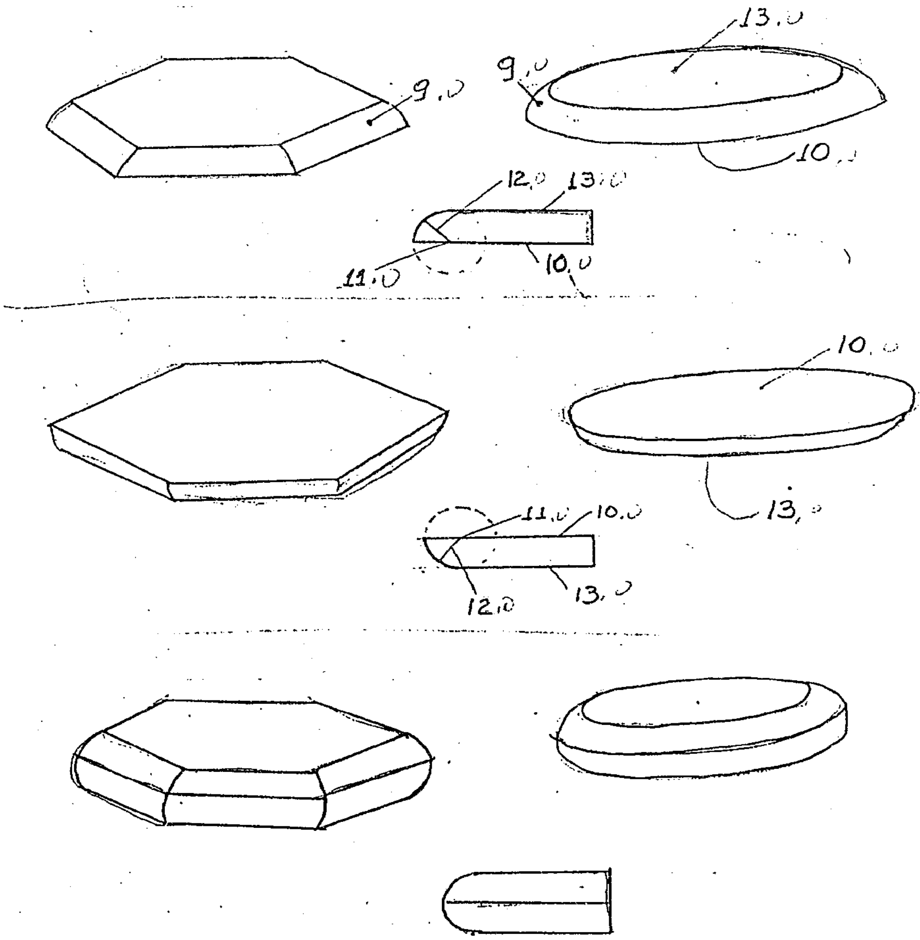

FIG.20

MNEMONIC CHART

POLYHEDRONS	CUBE 1	TETRA 2	OCTA 3	RHOMBIC 4	CUBOCTA 5	POLAR 6
FACES	FA1	FA2-3	FA2-3	FA4	FA1 FA2-3	FA6
VERTEXES	VE1	VE2	VE3	VE4	VE5	VE6
CENTRAL POINTS	CP1	CP2	CP3	CP4	CP5	CP6
PYRAMIDS	PY1	PY2	PY3	PY4	PY5S PY5T	PY6
FRUSTUMS	FR1	FR2	FR3	FR4	FR5S FR5T	FR6
TOP PORTIONS	TP1	TP2	TP3	TP4	TP5S TP5T	TP6
DIEDRAL ANGLES	AN1	AN2	AN3	AN4	AN5	AN6
DISTINCTIVE ANGLES	DA1	DA2-3 DA5T	DA2-3 DA5S	DA4	DA5S DA5T	DA6
PERIMETRICAL EDGES	PE1	PE2-3	PE2-3	PE4	PE5S PE5T	PE6
PERIMETRICAL FACES	PF1	PF2	PF3	PF4	PF5S PF5T	PF6
MODULES	M1	M2-3	M2-3	M4	M5S M5T	M6
PERIMETRICAL SIDES	PS1	PS2-3	PS2-3	PS4	PS5S PS5T	PS6
SKELETAL MODULES	SM1	SM2-3	SM2-3	SM4	SM5S SM5T	SM6

FIG. 21